E/ECE/324
E/ECE/TRANS/505 } Rev.1/Add.83
23 August 1991

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

Addendum 83: Regulation No. 84 annexed to the Agreement

Date of entry into force as an annex to the Agreement: 15 July 1990

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF PASSENGER CARS EQUIPPED WITH AN INTERNAL COMBUSTION ENGINE WITH REGARD TO THE MEASUREMENT OF FUEL CONSUMPTION

UNITED NATIONS

Regulation No. 84

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF PASSENGER CARS EQUIPPED WITH AN INTERNAL COMBUSTION ENGINE WITH REGARD TO THE MEASUREMENT OF FUEL CONSUMPTION

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Regulation No. 84

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF PASSENGER CARS EQUIPPED WITH AN INTERNAL COMBUSTION ENGINE WITH REGARD TO THE MEASUREMENT OF FUEL CONSUMPTION

1. SCOPE

1.1. This Regulation applies to the measurement of the fuel consumption indicated by the manufacturer, from all internal combustion engined vehicles of category M1 and of category N1, 1/ having a maximum total mass less than 2 tonnes.

2. DEFINITIONS

For the purposes of this Regulation,

2.1. "Approval of a vehicle" means the approval of a vehicle type with regard to the measurement of the fuel consumption;

2.2. "Vehicle type" means a category of power-driven vehicles which do not differ in such essential respects as: body, engine, transmission, tyres and unladen mass;

2.3. "Unladen mass" means the mass of the vehicle in running order without crew, passengers or load, but with the fuel tank full and the usual set of tools and spare wheel on board, where applicable;

2.4. "Reference mass" means the "unladen mass" of the vehicle increased by a uniform figure of 100 kg;

2.5. "Maximum mass" means the technically permissible maximum mass declared by the vehicle manufacturer (this mass may be greater than the maximum mass authorized by the national administration);

2.6. "Cold start device" means a device which enriches the air/fuel mixture of the engine temporarily, to assist starting;

2.7. "Starting aid" means a device which assists engine starting without enrichment of the air fuel mixture, e.g. glow plug, changed injection timing, etc.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to the measurement of the fuel consumption indicated by the manufacturer shall be submitted by the vehicle manufacturer or by his duly accredited representative.

3.2. It shall be accompanied by the undermentioned documents in triplicate and the following particulars:

3.2.1. A description of the engine type comprising all the particulars referred to in annex 1;

3.2.2. Description of the basic features of the vehicle, including those used in drafting annex 2.

3.3. A vehicle representative of the vehicle type to be approved shall be submitted to the technical services responsible for conducting approval tests.

3.4. The competent authority shall verify the existence of satisfactory provisions to ensure an effective check of conformity of production before approval of the vehicle type is granted.

4. APPROVAL

4.1. If the fuel consumption of the vehicle type submitted for approval pursuant to this Regulation has been measured according to the conditions specified in paragraph 5 below, approval of that vehicle type shall be granted.

4.2. An approval number shall be assigned to each type approved. Its first two digits (at present 00 for the regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another vehicle type.

4.3. Notice of approval or of extension or refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement applying this Regulation by means of a form conforming to the model in annex 2 to this Regulation.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation, an international approval mark consisting of:

4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval. 2/

4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.

4.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1 need not be repeated; in such a case, the Regulation and approval numbers and the additional symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

4.6. The approval mark shall be clearly legible and be indelible.

4.7. The approval mark shall be placed close to or on the vehicle data plate.

4.8. Annex 3 to this Regulation gives examples of arrangements of the approval mark.

5. SPECIFICATIONS AND TESTS

5.1. General

The components liable to affect the fuel consumption shall be so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which they may be subjected, to comply with the provisions of this Regulation.

5.2. Description of tests

5.2.1. The vehicle shall be subjected to the tests specified in annex 4 to this Regulation under the following driving conditions:

5.2.1.1. Cycle simulating urban driving;

5.2.1.2. Constant speed test at 90 km/h;

5.2.1.3. Constant speed test at 120 km/h. 3/

5.2.2. The results of the tests shall be expressed in litres/100 km rounded to 0.1 of a litre per 100 km.

5.2.3. The fuel used shall be the appropriate reference fuel defined by CEC: 4/

(a) in CEC document RF-03-A-84 for compression-ignition engines;

(b) one of those defined by CEC for positive ignition engines, in documents RF-01-A-84 and RF-08-A-85.

5.3. Interpretation of results

Fuel consumption values indicated by the manufacturer for the type of vehicle shall be accepted if they do not differ by more than ± 4% from the values measured b the technical service on the vehicle submitted for testing. If the difference is greater than 4%, the value adopted shall be that recorded by the technical service.

6. MODIFICATION AND EXTENSION OF APPROVAL OF THE VEHICLE TYPE

6.1. Every modification of the vehicle type shall be notifed to the administrative department which approved the vehicle type. The department may then either:

6.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect on fuel consumption values and that, in this case, the original approval will be valid for the modified vehicle type; or

6.1.2. Require a further test report from the technical service responsible for conducting the tests according to conditions in paragraph 7 of this Regulation.

6.2. Confirmation or extension of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3 above to the Parties to the Agreement applying this Regulation.

6.3. The competent authority which grants the extension of the approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

7. CONDITIONS OF EXTENSION OF THE TYPE APPROVAL FOR VEHICLE TYPE

7.1. Where the manufacturer produces, whether simultaneously or successively, vehicles which differ in certain respects but may be considered as variants of a single basic model, further consumption tests shall be carried out on each variant in the following cases:

7.1.1. Differences which necessitate repetition of the measurement of pollutant emissions required under Regulation No. 83 or under Regulation No. 24; further urban cycle and constant speed tests shall be carried out.

7.1.1.1. However, if the differences clearly affect consumption only in the urban cycle, the constant speed tests need not be performed.

7.1.2. Further constant speed tests shall be required in the following cases: modifications in the outer shape of the vehicle, such as the type of body (coupé, estate, saloon), addition of particular items (spoiler, deflector, etc.) or in the dimensions (wheelbase, track width) or mass of the vehicle. However, such further tests shall not be required if the manufacturer of the vehicle can show that the resulting change in total road load power on fuel consumption is less than 5%.

7.1.3. Further urban cycle tests shall be required in either of the following cases:

(a) a modification in the reference mass entails a change in the inertia class and the variation in mass is greater than 10%;

(b) a modification in the reference mass entails a change of more than one inertia class.

7.1.4. Modifications to the transmission system.

7.1.4.1. If the type of gear-box is changed (manual, automatic, number of ratios) additional urban cycle and constant speed tests shall be carried out.

7.1.4.2. If one or more of the overall transmission ratios (counting the effect of tyres) used in the urban cycle is changed by more than 8%, an additional urban cycle test shall be carried out.

7.1.4.3. If the overall transmission ratio (counting the effect of tyres) used for the constant speed tests is changed by more than 5%, additional constant speed tests shall be carried out.

7.1.4.4. Further tests will not normally be required in the case of a change of make of tyre, if the type and size are identical.

7.1.5. Modifications to the engine or its accessory equipment: additional urban cycle and constant speed tests shall be required in the case of the modifications defined below:

7.1.5.1. Significant modifications to the engine, in particular changes in the principal characteristics such as cylinder capacity, bore, stroke, design and dimensions of combustion chamber, valves or pistons, compression ratio, etc.

7.1.5.2. Significant changes in the pressure drop at the air filter or change in the type of filter (dry-air filter or oil-bath filter).

7.1.5.3. Addition or removal of an emission-control or economy device.

7.1.5.4. Modifications to the fuel supply system, e.g. to the inlet manifold, or addition of another air intake or air-preheating device.

7.1.5.5. A change in the make of carburettor or in the carburettor settings.

7.1.5.5.1. However, additional constant speed tests will not be required if the area of the 90-120 km/h flow bench curve utilized lies within the range of tolerances allowed for the carburettor used for the basic tests.

7.1.5.6. Changes in the settings of the injection system or in any of its component parts.

7.1.5.6.1. However, additional constant speed tests will not be required if the flow values and tolerances within the range used in proximity to the speeds in question lie within the range of tolerances allowed for the system used in the basic tests.

7.1.5.7. A change in the make or characteristics of the injectors.

7.1.5.8. Changes in the valve timing or setting.

7.1.5.9. Changes in the ignition system, such as changes in the type of ignition (conventional, transistorized or electronic), changes in the ignition curves (only if the operating ranges altered affect the operating points of the urban cycle or the constant speed runs) or modification of the initial ignition timing.

7.1.5.10. Changes in the exhaust manifold configuration likely to affect the gas flow.

7.1.5.11. Modifications of or changes in the exhaust box, silencer, resonator or tail pipe resulting in a variation in the exhaust back pressure exceeding 740 Pa, measured at the collector outlet under the operating conditions for each test. Only the corresponding tests need be repeated.

7.1.5.12. Changes in maximum engine power

7.1.5.12.1. If the change in maximum power is obtained solely by modification of the regulator cut-out action (max-min for instance) or of the stop which in some systems limits the opening of the throttle, no further test shall be required.

7.1.5.12.2. However, if the modifications referred to in 7.1.5.12.1 above have an effect on the operation of the engine within the range of use in question (all-speed governor, for instance), additional urban cycle and constant speed tests shall be carried out.

7.1.5.13. Addition of air-conditioning equipment, provided that the compressor is designed for continuous operation without producing excessive cold in the passenger compartment.

7.1.5.14. A change in the type or dimension of fan, type of drive system (mechanical or electric), temperature and speed regulating system, in so far as this change has an influence on the maximum power in the range of tolerance for engine speed.

7.2. However, in the case of minor modifications affecting the design of a whole range or series of vehicles, the additional tests need be carried out only on certain models selected from the range by the technical service. The variation in consumption measured in litres per 100 km thus found may be attributed to all the vehicles of the range affected by that modification only, with the agreement of the technical service.

7.3. For certain minor modifications, the manufacturer may submit to the technical service comparative results or technical proofs demonstrating that the modification has no significant effect on the consumption measurement results. The corresponding additional tests need not be carried out, provided the technical service agrees.

7.4. Interpretation of the results of further tests.

7.4.1. If no further tests are required for the variant, the consumption values attributed to the variant shall be those recorded for the basic model.

7.4.2. If further urban cycle and/or constant speed tests have been required for the variant:

7.4.2.1. The corresponding consumption values attributed to the variant shall be those of the basic model if the values measured on the variant during the further tests do not differ by more than ± 5% from the values recorded for the basic model.

7.4.2.1.1. However, at the request of the manufacturer the consumption values measured during the further tests may be attributed to each variant.

7.4.2.2. If the consumption values measured during the further tests differ by more than 5% from the values recorded for the basic model, they shall be attributed to the variant so tested.

7.4.2.3. The urban cycle or constant speed consumption values which need not be determined by further tests on the variant in question shall be those recorded for the basic model.

7.4.3. For the application of paragraphs 7.4.1 and 7.4.2 above, the basic reference model and its variants shall be selected in agreement with the technical service.

7.4.3.1. The establishment of a new basic model as a result of discontinued manufacture of the model initially approved, but not of its variants, may be requested by the manufacturer. In such case, the reference model selected, its variants and the further tests to be carried out shall be determined by agreement with the technical service.

8. CONFORMITY OF PRODUCTION

8.1. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved vehicle.

8.2. So as to verify that the conditions set out in paragraph 8.1 are complied with, appropriate production checks shall be carried out.

8.3. In particular, the holder of the approval shall:

8.3.1. Ensure the existence of procedures for the effective control of product quality;

8.3.2. Have access to the equipment necessary for checking conformity with each approved type;

8.3.3. Ensure that the data concerning the test results are recorded and that the annexed documents are available during a period to be agreed with the administrative service;

8.3.4. Analyse the results of each type of test so as to monitor and ensure the consistency of the characteristics of the product, taking into account the variations admissible in industrial manufacture;

8.3.5. Make sure that for each type of vehicle tests prescribed in annex 6 to this Regulation are carried out;

8.3.6. Make sure that any collections of samples or test pieces demonstrating non-conformity with the type of test under consideration is followed by a subsequent sampling and a further test. All necessary steps shall be taken to re-establish due conformity of production.

8.4. The competent authorities issuing the approval may verify at any time the methods applied in each production unit.

8.4.1. In every inspection, the records of tests and production monitoring shall be communicated to the visiting inspector.

8.4.2. The inspector may select at random the samples to be tested in the manufacturer's laboratory. The minimum number of samples may be determined on the basis of the results of the manufacturer's own checks.

8.4.3. When the quality standard does not seem satisfactory or when it seems necessary to verify the validity of the tests conducted under paragraph 8.4.2, the inspector shall collect samples to be sent to the technical service which carried out the approval tests.

8.4.4. The competent authorities may carry out all the tests prescribed in this Regulation.

8.4.5. Normally, the competent authorities shall conduct an inspection every two years. If, during one of these inspections, negative results are observed, the competent authority shall ensure that all necessary steps are taken to re-establish conformity of production as soon as possible.

9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8.1 above are not complied with.

9.2. If a Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in annex 2 to this Regulation.

10. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

11. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services responsible for conducting approval tests, and of the administrative departments which grant approval and to which, forms certifying approval or refusal or extension or withdrawal of approval, issued in other countries, are to be sent.

Notes

1/ Vehicle categories are described in the Consolidated Resolution on the Construction of Vehicles (R.E.3) (TRANS/SC1/WP29/78 and Amend.1).

2/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech and Slovak Federal Republic, 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal and 22 for the Union of Soviet Socialist Republics. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

3/ This test will not be done if the vehicle's maximum design speed is less than 130 km/h.

4/ European Coordinating Council for the development of performance tests for lubricants and engine fuels (CEC). Fuel characteristics are defined in Consolidated Resolution R.E.3 (document TRANS/SC1/WP29/78).

Annex 1

ESSENTIAL CHARACTERISTICS OF THE ENGINE AND INFORMATION CONCERNING THE CONDUCT OF TESTS 1/

1. Description of engine

1.1. Make .....

1.2. Type .....

1.3. Working principle: positive-ignition/compression-ignition four stroke/two stroke 3/

1.4. Bore ..... mm

1.5. Stroke ..... mm

1.6. Number and layout of cylinders and firing order .....

1.7. Cylinder capacity ..... cm^3

1.8. Compression ratio 2/ .....

1.9. Drawings of combustion chamber and piston crown .....

1.10. Minimum cross-sectional area of inlet and outlet ports .....

1.11. Cooling system: liquid/air cooling 3/

1.11.1. Characteristics of liquid-cooling system

Nature of liquid ..... Circulating pump: yes/no 3/

Characteristics or make(s) and type(s) of the pump .....

Drive ratio .....

Thermostat: setting .....

Radiator: drawing(s) or make(s) and type(s): .....

Relief valve: pressure setting: .....

Fan: characteristics or make(s) and type(s): .....

Fan drive system: ..... drive ratio: .....

Fan cowl: .....

1.11.2. Characteristics of air-cooling system

Blower: characteristics or make(s) and type(s) .... drive ratio: .

Air ducting (standard production): .....

Temperature regulating system: yes/no 3/ .....

Brief description .....

1.11.3. Temperatures permitted by the manufacturer

1.11.3.1. Liquid cooling: Maximum temperature at engine outlet .....

1.11.3.2. Air cooling: Reference point .....

Maximum temperature at reference point .....

1.11.3.3. Maximum outlet temperature of the inlet intercooler .....

1.11.3.4. Maximum exhaust temperature .....

1.11.3.5. Fuel temperature: min. ..... max. .....

1.11.3.6. Lubricant temperature: min. ..... max. .....

1.12. Pressure-charger: yes/no 3/ Description of the system .....

.....

1.13. Intake system

Intake manifold: ..... Description .....

Air filter: ..... Make: ..... Type: .....

Intake silencer: ..... Make: ..... Type: .....

1.14. Device for recycling crank-case gases (description and diagrams)

2. Additional anti-pollution devices (if any, and if not covered by another heading)

Description and diagrams .....

3. Air intake and fuel feed

3.1. Description and diagrams of inlet pipes and their accessories (dash-pot, heating device, additional air intakes, etc.)

.....

3.2. Fuel feed

3.2.1. By carburettor(s) 3/ ..... Number .....

3.2.1.1. Make .....

3.2.1.2. Type .....

3.2.1.3. Adjustments 2/

3.2.1.3.1. Jets		(
		(
3.2.1.3.2. Venturis		(
		(Curve of fuel delivery
3.2.1.3.3. Float-chamber level	or	(plotted against air flow,
		(and settings required to
3.2.1.3.4. Mass of float		(keep to the curve 2/ 3/
		(
3.2.1.3.5. Float needle		(

3.2.1.4. Manual/automatic choke 3/ ..... Closure setting 2/ .....

3.2.1.5. Feed pump

Pressure 2/ ..... or characteristic diagram 2/ .....

3.2.2. By fuel injection 3/ system description
Working principle: Intake manifold/direct injection
Injection prechamber/swirl chamber 3/

.....

3.2.2.1. Fuel pump .....

3.2.2.1.1. Make .....

3.2.2.1.2. Type .....

3.2.2.1.3. Delivery: ... mm^3 per stroke at a pump speed of rpm 3/ 2/
or, alternatively, a characteristic diagram 2/ 3/ .....
calibration procedure: test bench/engine 3/

.....

3.2.2.1.4. Injection timing .....

3.2.2.1.5. Injection curve .....

3.2.2.2. Injector nozzle .....

3.2.2.3. Governor .....

3.2.2.3.1. Make .....

3.2.2.3.2. Type .....

3.2.2.3.3. Cut-off point under load min.$^{-1}$ .....

3.2.2.3.4. Maximum speed without load min.$^{-1}$ .....

3.2.2.3.5. Idle speed .....

3.2.2.4. Cold start device .....

3.2.2.4.1. Make .....

3.2.2.4.2. Type .....

3.2.2.4.3. System description .....

3.2.2.5. Starting aid .....

3.2.2.5.1. Make .....

3.2.2.5.2. Type .....

3.2.2.5.3. System description .....

4. Valve timing or equivalent data

4.1 Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to top dead centre .....

.....

4.2. Reference and/or setting ranges 3/

5. Ignition

5.1. Ignition system type

5.1.1. Make .....

5.1.2. Type .....

5.1.3. Ignition advance curve 2/ .....

5.1.4. Ignition timing 2/ .....

5.1.5. Contact-point gap 2/ and dwell-angle 2/ 3/ .....

6. Exhaust system

Description and diagrams .....

7. Lubrication system

7.1. Description of system

7.1.1. Position of lubricant reservoir: .....

7.1.2. Feed system (pump, injection into intake, mixing with fuel, etc.)

.....

7.2. Lubricating pump 3/

7.2.1. Make .....

7.2.2. Type .....

7.3. Mixture with fuel 3/

7.3.1. Percentage

7.4. Oil cooler: yes/no 3/

7.4.1. Drawing(s) or make(s) and type(s) .....

8. Electrical equipment

Generator/alternator 3/: characteristics or make(s) and type(s)

.....

9. Other auxiliaries fitted on the engine

(Enumeration and brief description if necessary) .....

.....

10. Additional information on test conditions

10.1. Sparking plugs

10.1.1. Make .....

10.1.2. Type .....

10.1.3. Spark-gap setting .....

10.2. Ignition coil

10.2.1. Make .....

10.2.2. Type .....

10.3. Ignition condenser

10.3.1. Make .....

10.3.2. Type .....

10.4. Radio interference suppression equipment

10.4.1. Make .....

10.4.2. Type .....

11. Engine performance (declared by manufacturer)

11.1. Idle rpm 2/ .....

11.2. Carbon monoxide content by volume in the exhaust gas with the engine idling - per cent (manufacturer's standard)

.....

11.3. Rpm at maximum power 2/ .....

11.4. Maximum power - kW .....

12. Lubricant used .....

12.1. Make .....

12.2. Type .....

Notes

1/ In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

2/ Specify the tolerance.

3/ Delete as appropriate.

Annex 2

COMMUNICATION

(maximum format: A4 (210 x 297 mm)

issued by: Name of administration

.....

.....

.....

concerning: 2/ APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type pursuant to Regulation No. 84

Approval No. ..... Extension No. .....

1. Trade name or mark of the vehicle .....

2. Vehicle type .....

3. Vehicle category: M1, N1 - 2/ .....

4. Manufacturer's name and address .....

5. If applicable, name and address of manufacturer's representative

.....

6. Description of the vehicle: .....

6.1. Mass of the vehicle in running order: .....

6.2. Maximum permitted mass: .....

6.3. Type of body: saloon, estate, coupé: 2/ .....

6.4. Drive: front-wheel, rear-wheel, four-wheel: 2/ .....

6.5. Engine: .....

6.5.1. Cylinder capacity: .....

6.5.2. Fuel feed: carburettor, injection: 2/ .....

6.5.3. Fuel recommended by the manufacturer: .....

6.5.4. Maximum engine power: .....kW at ..... rpm .....

6.5.5. Super-charger: yes/no 2/ .....

6.5.6. Ignition: compression ignition, positive ignition (mechanical or electronic) 2/ .....

6.5.7. Exhaust gas cleaning device: yes/no 2/ .....

Type of additional anti-pollution device .....

6.6. Transmission .....

6.6.1. Type of gear box: manual, automatic, variable transmission 2/ .....

6.6.2. Number of gears .....

6.6.3. Overall transmission ratios (including tyre tread circumference under load): speed in km/h per engine 1000 rpm:

first gear: ..... fourth gear: .....

second gear: ..... fifth gear: .....

third gear: ..... overdrive: .....

6.6.4. Final torque ratio: .....

6.6.5. Tyres: .....

Type: ..... Dimensions: .....

Tread circumference under load: .....

7. Conventional fuel consumption:

Urban cycle..... 1/100 km

Constant speed at 90 km/h..... 1/100 km

Constant speed at 120 km/h..... 1/100 km

8. Vehicle submitted for approval on: .....

9. Technical service responsible for conducting approval tests: .....

10. Number of report issued by that service: .....

11. Date of report issued by that service: .....

12. Approval granted/extended/refused/withdrawn 2/ .....

13. Reasons for extension (if applicable): .....

14. Place .....

15. Date .....

16. Signature .....

Notes

1/ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

2/ Strike out what does not apply.

Annex 3

ARRANGEMENTS OF APPROVAL MARKS

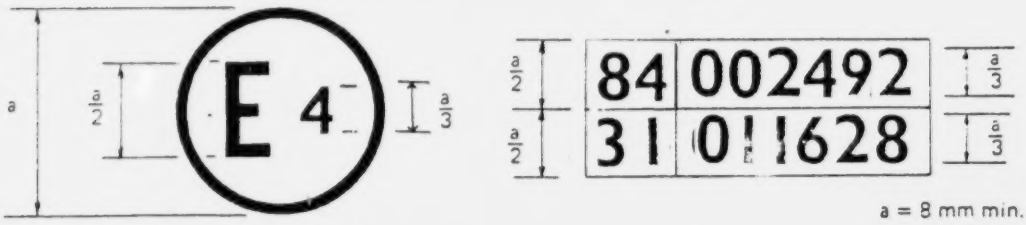
Model A

(see paragraph 4.4 of this Regulation)

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) with regard to the measurement of the fuel consumption pursuant to Regulation No. 84 and under the approval number 002492. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No. 84 in its original form.

Model B

(see paragraph 4.5 of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. 84 and 31. 1/ The first two digits of the approval numbers indicate that, at the dates when the respective approvals were granted, Regulation No. 84 had not been modified, and Regulation No. 31 already included the 01 series of amendments.

Note

1/ The second number is given merely as an example.

Annex 4

ECE METHOD OF MEASURING FUEL CONSUMPTION

1. TEST CONDITIONS

1.1. General condition of the vehicle

1.1.1. The vehicle shall have been run in and shall have been driven for at least 3,000 km before the test.

1.1.2. The settings of the engine and of the vehicle's controls shall be those prescribed by the manufacturer. This requirement also applies, in particular, to the settings for idling (rotation speed and carbon monoxide (CO) content of the exhaust gases), for the cold start device and for the exhaust gas cleaning system.

1.1.3. The tightness of the inlet system may be checked to ensure that carburation is not affected by an accidental intake of air.

1.1.4. The laboratory may verify that the vehicle conforms to the performance stated by the manufacturer, that it can be used for normal driving and, more particularly, that it is capable of starting when cold and when hot.

1.1.5. Before the test, the vehicle shall be kept in a room in which the temperature remains relatively constant between 20° C and 30° C. This conditioning shall be carried out for at least six hours and shall continue until the engine oil temperature and coolant, if any, have reached the temperature of the room to within ± 2° C. At the request of the manufacturer, the test shall be carried out not later than 30 hours after the vehicle has been run at its normal temperature.

1.1.6. The vehicle shall be clean, with the windows and air intakes closed, and only the equipment necessary for the operation of the vehicle during the test shall be in use. If there is a manually controlled device for the engine intake air temperature, it shall be in the position prescribed by the manufacturer for the ambient temperature at which the test is performed. In general, the auxiliary devices required for the normal operation of the vehicle shall be in use.

1.1.7. If the radiator fan is temperature controlled, it shall be in the condition of normal operation on the vehicle. The passenger compartment heating system shall be switched off, as shall any air conditioning system, but such system's compressor shall be functioning normally.

1.1.8. If a super-charger is fitted, it shall be in the normal operating condition for the test conditions.

1.1.9. If a four-wheel drive vehicle is tested with only two driving wheels engaged, this shall be stated in the test report and the fuel consumption figures given.

1.2. Lubricants

All the lubricants shall be those recommended by the manufacturer of the vehicle and shall be specified in the test report.

1.3. Tyres

The tyres shall be of a type specified as original equipment by the vehicle manufacturer and shall be inflated to the pressure recommended by the vehicle manufacturer for the highest test load and speed (adapted if appropriate for bench running in the test conditions). These pressures shall be indicated in the test report. The tyres shall either have been run in at the same time as the vehicle or shall have a tread depth between 90% and 50% of the original tread depth.

1.4. Test fuel

Test fuels shall have the characteristics of the CEC reference fuels defined in Consolidated Resolution (R.E.3)*.

1.5. Measuring the fuel consumption

1.5.1. Distances shall be measured to an accuracy of 0.3% and times to an accuracy of 0.2 s. The measurement systems for the fuel consumed, for the distance covered and for the time, shall be engaged simultaneously.

1.5.2. Fuel shall be supplied to the engine through a device capable of measuring the quantity consumed to within ± 2%; this device shall not influence the pressure or the temperature of the fuel at the inlet of the fuel metering system by more than ± 10% for pressure and ± 5° C (5 K) for fuel temperature. If the system of measurement is volumetric, the temperature of the fuel at the point of measurement shall be measured.

1.5.3. If necessary, a valve system shall be used for rapid change-over from the normal fuel supply line to the measuring system. The change-over shall not take longer than 0.2 s.

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* Document TRANS/SC1/WP29/78.

1.6. Reference conditions

Total pressure: H_o = 100 kPa
Temperature: T_o = 293 K (20° C)

1.6.1. Air density

1.6.1.1. The air density when the vehicle is tested, calculated as described in paragraph 1.6.1.2 below, shall not differ by more than 7.5% from the air density under the reference conditions.

1.6.1.2. The air density shall be calculated by the formula:

$$d_T = d_o \cdot \frac{H_T}{H_o} \cdot \frac{T_o}{T_T}$$, where

d_T = air density at test conditions
d_o = air density at reference conditions
H_T = total pressure during the test
T_T = absolute temperature during the test (K)

1.6.2. Ambient conditions

1.6.2.1. The ambient temperature shall be between 5° C (278 K) and 35° C (308 K) and the barometric pressure between 91 kPa and 104 kPa. The relative humidity shall be less than 95%.

1.6.2.2. However, with the manufacturer's agreement, the tests may be made at lower ambient temperatures down to 1° C. In this case, the correction factor calculated for 5° C should be used (see para. 3.3.1.9).

1.7. Fuel consumption calculation

1.7.1. If the fuel consumption is measured gravimetrically, the consumption "C" shall be expressed (in litres/100 km) by converting the measurement M (fuel consumed expressed in kilograms) using the following formula:

$$C = \frac{M}{D \cdot S_g} \; 100 \text{ (litres/100 km)}$$

where:

S_g: density of the fuel (kg/dm^3) at the reference temperature of 20° C (293 K)

D = actual distance covered during the test (km)

1.7.2. If the fuel consumption is measured volumetrically the consumption "C" shall be expressed (in litres/100 km) by the following formula:

$$C = \frac{V\ (1 + \alpha\ (T_o - T_F))}{D}\ 100\ \text{(litres/100 km)}$$

where:

V : volume of fuel consumed (litres)

α : coefficient of volumetric expansion for the fuel (0.001 per ° C for both diesel fuel and petrol)

T_o: reference temperature expressed in ° C: 20° C (293 K)

T_F: average temperature of fuel expressed in ° C and calculated as the arithmetic mean of the fuel temperature measurements taken in the volumetric measuring device at the beginning and at the end of the test

2. MEASUREMENT OF FUEL CONSUMPTION ON A CYCLE SIMULATING URBAN DRIVING

2.1. The test cycle shall be that described in annex 5 to this Regulation.

2.1.1. Test mass of the vehicle

2.1.1.1. The test mass of category M1 vehicles shall be the reference mass as defined in paragraph 2.4 of this Regulation.

2.1.1.2. The unladen mass shall be as defined in paragraph 2.3 of this Regulation.

2.1.1.3. The test mass of category N1 vehicles shall be the unladen kerb mass plus 180 kg or half the vehicle's maximum load if greater than 180 kg, including the measuring equipment and occupants.

2.1.1.4. For category N1 vehicles, the load shall be distributed as specified in paragraph 3.1.1.4 of this annex.

2.2. The chassis dynamometer shall be set with the equivalent inertia test mass I in accordance with the following table:

Test mass of vehicle Tmv (kg)	Equivalent inertia test mass I (kg)
Tmv < 480	455
480 < " < 540	510
540 < " < 595	570
595 < " < 650	625
650 < " < 710	680
710 < " < 765	740
765 < " < 850	800
850 < " < 965	910
965 < " < 1 080	1 020
1 080 < " < 1 190	1 130
1 190 < " < 1 305	1 250
1 305 < " < 1 420	1 360
1 420 < " < 1 530	1 475
1 530 < " < 1 640	1 590
1 640 < " < 1 760	1 700
1 760 < " < 1 930	1 800
1 930 < " < 2 155	2 040
2 155 < " <	2 270

If the equivalent inertia test mass I specified is not available on the dynamometer used, the nearest available equivalent test mass greater than the reference mass shall be used.

2.2.1. The load of the dynamometer shall be set. The total actual road load power shall be determined with the vehicle test mass as specified in paragraph 2.1.1 of this annex.

2.3. Measurement of consumption

2.3.1. Consumption shall be determined from the quantity of fuel consumed during two consecutive cycles.

2.3.2. The engine shall be conditioned by carrying out a sufficient number of complete cycles of the type described in annex 5 to this Regulation to reach a stabilized temperature for oil temperature in particular; not less than five cycles shall be carried out.

The engine temperatures shall be maintained within their normal range of operation as specified by the manufacturer, if necessary by means of an auxiliary cooling device.

2.3.3. The idling period between consecutive pairs of cycles may be extended by not more than 60 s to facilitate fuel measurement.

2.4. Presentation of results

2.4.1. The standard consumption in the urban cycle shall be the arithmetical mean of at least three consecutive measurements carried out in accordance with the procedure described above.

2.4.2. If the extreme measurements of the first three tests differ by more than 5% from the mean value, further tests shall be carried out in accordance with this procedure in order to obtain a degree of accuracy of measurement at least equal to 5%.

2.4.3. The accuracy of the measurement shall be calculated by the formula:

$$\text{accuracy} = \left(k \cdot \frac{S}{\sqrt{n}} \cdot \frac{100}{\bar{C}}\right) \%$$

where:

$\bar{C}$ is the arithmetical mean of n values C

C is given by the formulae in paragraph 1.7

n is the number of measurements taken

$$S = \sqrt{\frac{\sum_{i=1}^{i=n} (\bar{C} - C_i)^2}{n - 1}}$$

k is given by the following table:

Number of measurements "n"	4	5	6	7	8	9	10
k	3.2	2.8	2.6	2.5	2.4	2.3	2.3

2.4.4. If an accuracy of 5% has not been attained after 10 measurements, the consumption shall be determined by using another vehicle of the same type.

3. MEASUREMENT OF FUEL CONSUMPTION AT CONSTANT SPEED

3.1. These tests may be carried out either on a chassis dynamometer or on a track.

3.1.1. Test mass of the vehicle

The mass of the vehicle shall be the unladen mass as defined in paragraph 2.3 of the present Regulation plus 180 kg, or half the useful load if more than 180 kg, including measuring equipment and occupants.

3.1.1.1. For category M1 vehicles, the attitude of the vehicle shall be that obtained when the centre of gravity of this load is placed in the middle of the straight line joining the R points* of the front side seats.

3.1.1.2. For vehicles with not more than two rows of seats, the attitude of the vehicle shall be that obtained when the centre of gravity of this load is placed in the middle of the straight line joining the R points of the front side seats.

3.1.1.3. For vehicles with more than two rows of seats, the attitude of the vehicle shall be that obtained when the centre of gravity of the first 180 kg is placed as described above and the centre of gravity of the additional load is placed on the centre line of the vehicle between the point defined above for the front seats and the equivalent point for the second row of seats.

3.1.1.4. For category N1 vehicles, the additional load, defined as the total load prescribed for the test less the mass of the occupants and the measuring equipment, shall be placed in the centre of the vehicle's loading surface.

3.2. Gearbox

3.2.1. If the maximum speed of the vehicle exceeds 130 km/h in the highest (nth) gear, only that gear shall be used to determine fuel consumption.

3.2.2. If the maximum speed exceeds 130 km/h in the (n-1)th gear but only 120 km/h in the nth gear, the test at 120 km shall be conducted in the (n-1)th gear, but the manufacturer may request that the fuel consumption at 120 km/h shall be determined for both those gears, provided it is possible in the nth gear to satisfy the requirements of paragraph 3.3.1.5. In this case, both values shall be entered in paragraph 7 of annex 2.

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* See Consolidated Resolution R.E.3 (document TRANS/SC1/WP29/78).

3.3. Test procedure

3.3.1. Track test

3.3.1.1. Road and weather conditions

3.3.1.1.1. The road shall be dry; the road surface may, however, bear traces of moisture, provided that there is no appreciable film of water in any area.

3.3.1.1.2. The average wind speed shall be less than 3 m/s and gusts shall not exceed 8 m/s.

3.3.1.2. Before proceeding to the first measurement, the vehicle shall be sufficiently warmed up to normal operating conditions. Before each measured run, the vehicle shall be stabilized in temperature on the test track at least by a 5 km run as close as possible to the test speed (in any case within ± 5% of the test speed).

Alternatively, speed variations greater than ± 5% are allowed during vehicle temperature stabilization. In this case, it shall be shown that when the fuel consumption measurement is made, the coolant, lubricant and fuel temperatures do not vary by more than ± 3° C.

3.3.1.3. Test run

The measured test run shall be at least 2 km in length. It shall be either a closed circuit (the complete circuit length of a closed track shall be used for each measured test run) or a straight track (the test run shall be made in both directions).

The test track shall allow a steady speed to be maintained in accordance with the above requirements. The surface shall be in good condition. The gradient shall not exceed ± 2% between any two points more than two metres apart.

3.3.1.4. To determine the consumption at a steady reference speed, at least two measurements shall be made below or at the reference speed and at least two others at or above the reference speed, but not exceeding the tolerances prescribed below.

3.3.1.5. During each test run, the speed shall be kept steady within ± 2 km/h. The average speed for each test shall not differ from the reference speed by more than 2 km/h.

3.3.1.6. The fuel consumption for each test run shall be calculated by the formulae in paragraph 1.7.

3.3.1.7. The consumption at the reference speed shall be calculated by linear regression of the test data obtained in 3.3.1.4. In the case of tests performed in two directions of the test track, data points obtained in each direction shall be introduced individually.

The consumption shall be determined within ± 3% at a 95% confidence level. To achieve this accuracy, the number of tests may be increased. The accuracy is defined by the following formula:

$$\text{Accuracy} = k \cdot \frac{\sqrt{\frac{(c_i - c_i)^2}{n-2}} \cdot \sqrt{\frac{1}{n} + \frac{(V_{ref} - \bar{V})^2}{(V_i - V)}}}{C} \cdot 100$$

where:

c_i: measured consumption at the speed V_i

c_i: consumption at the speed V_i calculated by regression

C: consumption at the reference speed V calculated by regression

V_{ref}: reference speed

V_i: actual speed of determination i

$\bar{V}$: average speed $= \frac{\sum V_i}{n}$

n: number of tests

k is given by the following table:

n	4	5	6	7	8	9	10
k	4.30	3.18	2.78	2.57	2.45	2.37	2.31
n	12	14	16	18	20		
k	2.23	2.18	2.15	2.12	2.10		

3.3.1.8. If consumption is measured at an average speed equal to the reference speed ± 0.5 km/h, the consumption at the reference speed may be calculated by the average of the test data obtained.

The accuracy of the measurement of consumption as defined in paragraph 3.3.1.7 of this annex shall not vary by more than ± 3% from the 95% confidence level of measurement.

3.3.1.9. Correction of test results

3.3.1.9.1. The fuel consumption values determined within the defined atmospheric limits shall be corrected to the reference conditions (100 kPa, 20° C (293 K)) by the following formula:

$$C_{corrected} = K \cdot C_{measured}$$

where:

$C_{corrected}$: consumption in litres/100 km in the reference conditions

K: correction factor

$C_{measured}$: consumption in litres/100 km measured in the test ambient conditions

The factor K is equal to:

$$K = \frac{R_R}{R_T}\left[1 + K_R\,(t - t_o)\right] + \frac{R_{AERO}}{R_T} \cdot \frac{(\rho 0)}{\rho}$$

where:

R_R: rolling resistance at the test speed

R_{AERO}: aerodynamic resistance at the test speed

R_T: total road load resistance = $R_R + R_{AERO}$

t: test ambient temperature in ° C

t_o: reference ambient temperature (= 20° C)

K_R: temperature correction factor of rolling assistance, to be taken as equal to:

$3.6 \cdot 10^{-3}$ /° C

ρ: air density in the test conditions

ρo: air density in the reference conditions (= 1.189 kg/m^3)

3.3.1.9.2. The values R_R, R_{AERO} and R_T shall be provided by the vehicle manufacturer on the basis of the data normally available within the undertaking. If these values are not available, with the manufacturer's agreement the values given in paragraph 5.1.1.2.8 of annex 5, appendix 3 to this Regulation may be used.

3.3.1.9.3. If during the constant speed test there is any change in the ambient conditions greater than 2° C or 0.7 kPa, the correction factor given in paragraph 3.3.1.9.1 shall be applied before determining the consumption or the degree of accuracy.

3.3.2. Chassis dynamometer test

3.3.2.1. The characteristics of the dynamometer shall comply with the requirements in annex 5, appendix 2 to this Regulation.

3.3.2.2. The conditions in the test chamber shall be capable of adjustment so that the vehicle can be tested in its normal operating conditions with the temperatures of lubricants, coolant and fuel within the range normally obtained at the same speed on the road. The manufacturer shall if required confirm those temperature ranges on the basis of data previously obtained during road tests with comparable engine/vehicle configurations.

3.3.2.3. Preparation of the vehicle for the bench test

3.3.2.3.1. The vehicle shall be loaded to the same mass as for the road.

3.3.2.3.2. The tyres of the driven wheels shall meet the conditions defined in paragraph 1.3 of this annex.

3.3.2.3.3. The vehicle shall be positioned on the bench so that:

its longitudinal axis is perpendicular to the axis of the roller or rollers

the anchorage system for the vehicle does not increase the load on the driving wheels

3.3.2.3.4. After warming-up, the vehicle shall be run on the bench at a speed close to the test speed long enough to allow stabilization of the vehicle temperatures by regulation of the auxiliary cooling system.

This preconditioning time shall not be less than five minutes.

3.3.2.4. Test procedure

3.3.2.4.1. The bench shall be set as described in paragraph 5.1.2 of appendix 3 to annex 5. The bench shall be set for the appropriate test speed and the test mass defined in paragraph 3.1.1 for determining the total road load power.

3.3.2.4.2. The test distance shall be not less than 2 km and shall be measured with a suitable device.

3.3.2.4.3. The inertia device may be disconnected during the test provided that the speed variation does not exceed an amplitude of 0.5 km/h during the actual test.

3.3.2.4.4. Not less than four measurements shall be taken.

3.3.2.4.5. The provisions of paragraphs 3.3.1.4, 3.3.1.5, 3.3.1.6, 3.3.1.7 and 3.3.1.8 shall apply as appropriate.

3.3.2.5. The type of dynamometer used shall be indicated in the test report.

4. PRESENTATION OF RESULTS

4.1. Whatever the method of measurement used, the results shall be expressed in volume under the reference conditions specified in paragraph 1.6 of this annex.

Annex 5

TESTS ON THE CHASSIS DYNAMOMETER - URBAN CYCLE TESTS

1. INTRODUCTION

This annex describes the procedure for the test required in paragraph 5.2.1.1. of the Regulation.

2. OPERATING CYCLE ON THE CHASSIS DYNAMOMETER

2.1. Description of the cycle

The operating cycle on the chassis dynamometer shall be that indicated in the following table and depicted in the graph in appendix 1 to this annex. The breakdown by operations is also given in the table in the said appendix.

2.2. General conditions under which the cycle is carried out

Preliminary testing cycles should be carried out if necessary to determine how best to actuate the accelerator and brake controls so as to achieve a cycle approximating to the theoretical cycle within the prescribed limits.

2.3. Use of the gear-box

2.3.1. If the maximum speed which can be attained in first gear is below 15 km/h the second, third and fourth gears shall be used. The second, third and fourth gears may also be used when the driving instructions recommend starting in second gear on level ground, or when first gear is therein defined as a gear reserved for cross-country driving, crawling or towing.

2.3.2. Vehicles equipped with semi-automatic-shift gear-boxes shall be tested by using the gears normally employed for driving, and the gear shift shall be used in accordance with the manufacturer's instructions.

2.3.3. Vehicles equipped with automatic-shift gear-boxes shall be tested with the highest gear ("Drive") engaged. The accelerator shall be used in such a way as to obtain the steadiest acceleration possible, enabling the various gears to be engaged in the normal order. Furthermore, the gear-change points shown in appendix 1 to this annex shall not apply: acceleration shall continue throughout the period represented by the straight line connecting the end of each period of idling with the beginning of the following period of steady speed. The tolerances given in paragraph 2.4. below shall apply.

OPERATING CYCLE ON THE CHASSIS DYNAMOMETER

No. of operation		Phase	Acceleration (m/s^2)	Speed (km/h)	Duration of each		Cumulative time (s)	Gear to be used in the case of a manual shift
					Operation (s)	Phase (s)		
1	Idling	1			11	11	11	6 s .PM+5 s .K1*
2	Acceleration	2	1.04	0 - 15	4	4	15	1
3	Steady speed	3		15	8	8	23	1
4	Deceleration		-0.69	15 - 10	2	2	25	1
5	Deceleration, clutch disengaged	4	0.92	10 - 0	3	3	28	K1
6	Idling	5			21	21	49	16 s .PM+5 s .K1
7	Acceleration	6	0.83	0 - 15	5	12	54	1
8	Shifting of gears	6			2		56	
9	Acceleration	6	0.94	15 - 32	5		61	2
10	Steady speed	7		32	24	24	85	2
11	Deceleration	8	-0.75	32 - 10	8	11	93	2
12	Deceleration, clutch disengaged	8	-0.92	10 - 0	3		96	K2
13	Idling	9			21	21	117	16 s .PM+5 s .K1
14	Acceleration	10	0.83	0 - 15	5	26	122	1
15	Shifting of gears	10			2		124	
16	Acceleration	10	0.62	15 - 35	9		133	2
17	Shifting of gears	10			2		135	
18	Acceleration	10	0.52	35 - 50	8		143	3
19	Steady speed	11		50	12	12	155	3
20	Deceleration	12	-0.52	50 - 35	8	8	163	3
21	Speedy speed	13		35	13	13	176	3
22	Shifting of gears	14			2	12	178	
23	Deceleration	14	-0.86	32 - 10	7		185	2
24	Deceleration, clutch disengaged	14	0.92	10 - 0	3		188	K2
25	Idling	15			7	7	195	7 s PM

* PM + Gears in neutral, clutch engaged.

K1, K2 = First or second gear engaged, clutch disengaged.

2.3.4. Vehicles equipped with an overdrive which the driver can actuate shall be tested with the overdrive out of action.

2.3.5. In view of the limitations inherent in existing facilities, four-wheel drive vehicles may be tested on dynamometers designed for two-wheel drive vehicles; this shall be noted in the test report.

2.4. Tolerances

2.4.1. A tolerance of ± 1 km/h shall be allowed between the indicated speed and theoretical speed during acceleration, during steady speed, and during deceleration when the vehicle's brakes are used. If the vehicle decelerates more rapidly without the use of the brakes, only the provisions of paragraph 5.5.3. below shall apply. Speed tolerances greater than those prescribed shall be accepted during phase changes, provided that the tolerances are never exeeded for more than 0.5 seconds on any one occasion.

2.4.2. Time tolerances of ± 0.5 seconds. The above tolerances shall apply equally at the beginning and at the end of each gear-changing period. 1/

2.4.3. The speed and time tolerances shall be combined as indicated in appendix 1 to this annex.

3. TEST VEHICLE

The vehicle to be tested, or an equivalent vehicle, shall be fitted, if necessary, with a device to permit the measurement of the characteristic parameters necessary for chassis dynamometer setting, in conformity with paragraph 4.1. of this annex.

4. TEST EQUIPMENT: CHASSIS DYNAMOMETER

4.1. The dynamometer must be capable of simulating road load within one of the following classifications:

Dynamometer with fixed load curve, i.e. a dynamometer whose physical characteristics provide a fixed load curve shape;

Dynamometer with adjustable load curve, i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve.

4.2. The setting of the dynamometer shall not be affected by the lapse of time. It shall not produce any vibrations perceptible to the vehicle and likely to impair the vehicle's normal operations. The characteristics of the dynamometer shall comply with the specifications set out in this annex, appendix 2, paragraph 1.2.2.

4.3. It shall be equipped with means to simulate inertia and load. These simulators shall be connected to the front roller, in the case of a two-roller dynamometer.

4.4. Accuracy

The total inertia of the rotating parts (including the simulated inertia, where applicable) must be known and be within ± 20 kg of the equivalent inertia test mass prescribed.

4.5. Loading setting

4.5.1. The absorber unit shall be adjusted to simulate the total road load power in relation to speed; it shall in no case be negative. The accuracy of regulation shall be ± 3% at 50 km/h, ± 5% at 40 and 30 km/h and ± 10% at 20 km/h. If the dynamometer is not capable of complying with the upper tolerance limit at speeds below 50 km/h, as specified above, the test results may be accepted, subject to the agreement of the manufacturer and the technical service.

4.5.2. The procedures for determining the total road load power and the calibration of the dynamometer are defined in appendix 3 to this annex.

4.6. Inertia setting

Dynamometers with electrical inertia simulation must be demonstrated to be equivalent to mechanical inertia systems. The means by which equivalence is established is described in appendix 4 to this annex.

5. PROCEDURE FOR BENCH TESTS

5.1. Special conditions for carrying out the cycle

5.1.1. During the test, the test cell temperature shall be between 20° C and 30° C. The absolute humidity (H) of either the air in the test cell or the intake air of the engine shall be such that:

$$5.5 < H < 12.2 g H_2O/kg \text{ dry air}$$

5.1.2. The vehicle shall be approximately horizontal during the test so as to avoid any abnormal distribution of the fuel.

5.1.3. The test shall be carried out with the bonnet raised unless this is technically impossible. An auxiliary ventilating device acting on the radiator (water-cooling) or on the air intake (air-cooling) may be used if necessary to keep the engine temperature normal.

5.1.4. During the test the speed shall be recorded against time so that the correctness of the cycles performed can be assessed.

5.2. Starting-up the engine

5.2.1. The engine shall be started up by means of the devices provided for this purpose according to the manufacturer's instructions, as incorporated in the driver's handbook of production vehicles.

5.2.2. The engine shall be kept idling for a period of 40 seconds. The first cycle shall begin at the end of the aforesaid period of 40 seconds at idle.

5.3. Idling

5.3.1. Manual-shift or semi-automatic gear-box

5.3.1.1. During periods of idling, the clutch shall be engaged and the gears in neutral.

5.3.1.2. To enable the accelerations to be performed according to the normal cycle, the vehicle shall be placed in first gear, with the clutch disengaged, five seconds before the acceleration following the idling period considered.

5.3.1.3. The first idling period at the beginning of the cycle shall consist of six seconds of idling in neutral with the clutch engaged and five seconds in first gear with the clutch disengaged.

5.3.1.4. For the idling periods during each cycle, the corresponding time shall be 16 seconds in neutral and 5 seconds in first gear with the clutch disengaged.

5.3.1.5. The idling period between two successive cycles shall comprise 13 seconds in neutral with the clutch engaged.

5.3.2. Automatic-shift gear-box

After initial engagement the selector shall not be operated at any time during the test except in accordance with paragraph 5.4.3. below.

5.4. Accelerations

5.4.1. Accelerations shall be so performed that the rate of acceleration is as constant as possible throughout the phase.

5.4.2. If an acceleration cannot be carried out in the prescribed time, the extra time required shall be deducted from the time allowed for changing the combination, if possible, and in any case, from the subsequent steady-speed period.

5.4.3. Automatic-shift gear-boxes

If an acceleration cannot be carried out in the prescribed time, the gear selector shall be operated in accordance with requirements for manual-shift gear-boxes.

5.5. Decelerations

5.5.1. All decelerations shall be effected by removing the foot completely from the accelerator, the clutch remaining engaged. The clutch shall be disengaged, without use of the gear lever, at a speed of 10 km/h.

5.5.2. If the period of deceleration is longer than that prescribed for the corresponding phase, the vehicle's brakes shall be used to enable the timing of the cycle to be abided by.

5.5.3. If the period of deceleration is shorter than that prescribed for the corresponding phase, the timing of the theoretical cycle shall be restored by constant speed or idling period merging into the following operation.

5.5.4. At the end of the deceleration period (halt of the vehicle on the rollers) the gears shall be placed in neutral and the clutch engaged.

5.6. Steady speeds

5.6.1. "Pumping" or the closing of the throttle shall be avoided when passing from acceleration to the following steady speed.

5.6.2. Periods of constant speed shall be achieved by keeping the accelerator position fixed.

Notes

1/ It should be noted that the time of two seconds allowed includes the time for changing the combination and, if necessary, a certain amount of latitude to catch up with the cycle.

Annex 5 - Appendix 1

BREAKDOWN OF THE OPERATING CYCLE OF URBAN DRIVING

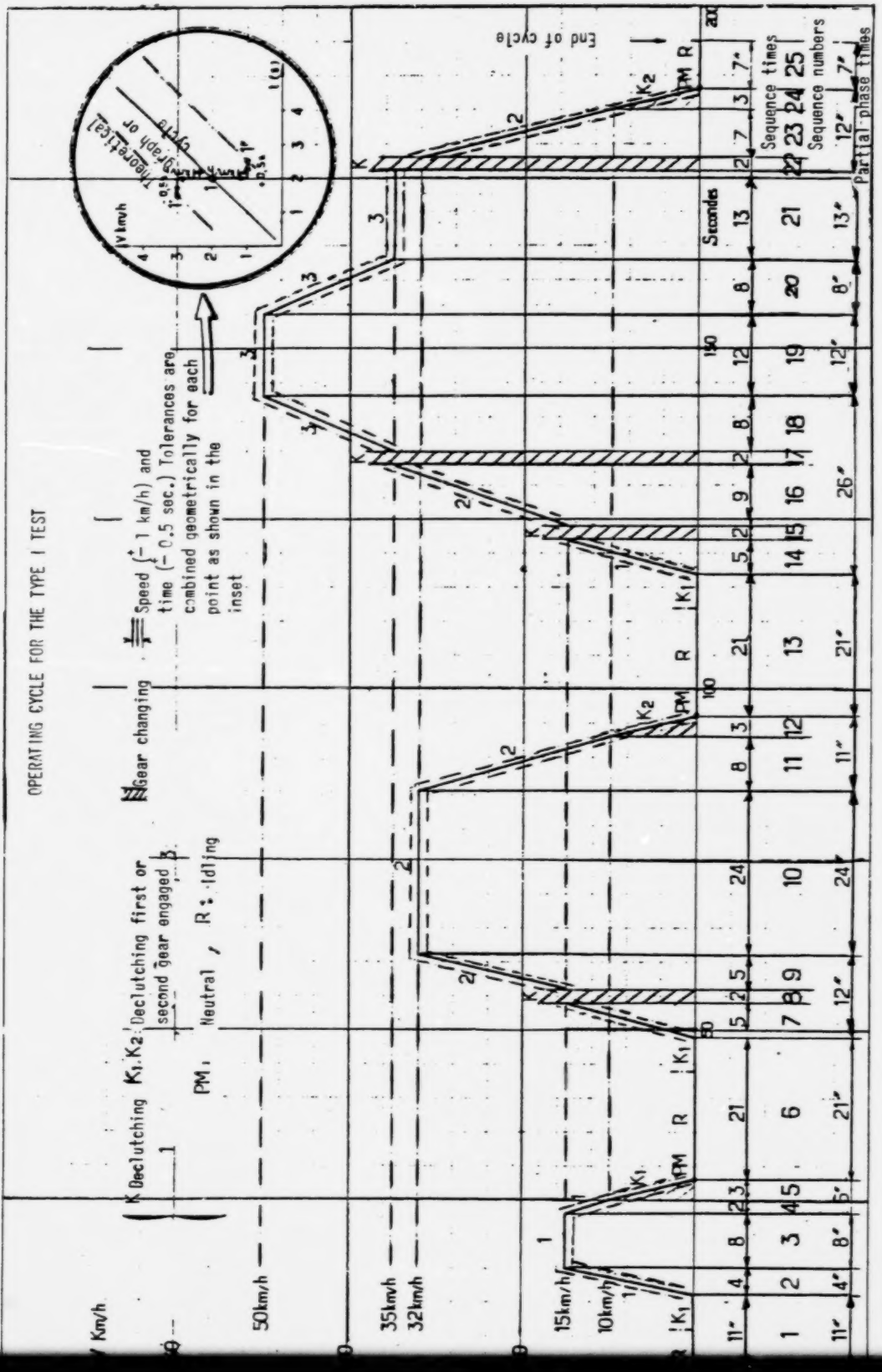
	Time	Percentage	
(1) Breakdown by phases			
Idling	60 s	30.8)	
Idling, vehicle moving, clutch engaged on one combination	9 s	4.6)	35.4
Gear-shift	8 s		4.1
Accelerations	36 s		18.5
Steady-speed periods	57 s		29.2
Decelerations	25 s		12.8
	195 s		100 %
(2) Breakdown by use of gears			
Idling	60 s	30.8)	
Idling, vehicle moving, clutch engaged on one combination	9 s	4.6)	35.4
Gear-shift	8 s		4.1
First gear	24 s		12.3
Second gear	53 s		27.2
Third gear	41 s		21
	195 s		100 %

Average speed during test: 19 km/h.

Effective running time: 195 s.

Theoretical distance covered per cycle: 1.013 km.

Equivalent distance for the test (4 cycles): 4.052 km.


OPERATING CYCLE FOR THE TYPE I TEST
Km/h
50km/h
35km/h
32km/h
15km/h
10km/h
K Declutching
K1.K2 Declutching first or second gear engaged
PM, Neutral, R: Idling
Gear changing
Speed (± 1 km/h) and time (± 0.5 sec.) Tolerances are combined geometrically for each point as shown in the inset
Theoretical cycle
End of cycle
Seconds
Sequence times
Sequence numbers
Partial phase times

Annex 5 - Appendix 2

CHARACTERISTICS OF THE CHASSIS DYNAMOMETER

1. DEFINITION OF CHASSIS DYNAMOMETER

1.1. Introduction

This appendix deals with the characteristics of the chassis dynamometer to be used both for urban emission and fuel consumption measurements and for constant speed fuel consumption determination (see appendix 3).

1.2. Definition

1.2.1. Terminology

The following terminology shall be used in this appendix and in appendix 3:

P_T = total road load power (on track or dynamometer)

P_i = power indicated and absorbed by the power absorption unit of the dynamometer

P_f = frictional losses in dynamometer

P_a = power absorbed by the dynamometer = $P_f + P_i$

P_R = power absorbed by rolling resistance.

At constant speed on the dynamometer the following relationship shall apply: $P_T = P_R + P_a = P_R + P_f + P_i$

1.2.2. Characteristics of the dynamometer

The dynamometer may have one or two rollers, which may be coupled. The front roller shall drive the power absorption unit device, the inertia simulation unit and the system for measuring the speed and the distance covered.

The dynamometer shall meet the following conditions:

(a) Consistent simulation of the road load power within ± 3% for speeds of 50 km/h or above;

(b) Constant maintenance of the absorbed power as set throughout the test period within ± 1% at the set speed;

(c) Margin of error not exceeding ± 0.5 km/h for speeds higher than 10 km/h and ± 0.3% for measurement of the distance covered. However, the operation of any driver aid device must allow for the cycle tolerances given in paragraph 2.4.1. of this annex;

(d) When used to determine fuel consumption, the measurement systems for the fuel consumed, for the distance covered and for time shall be simultaneously engaged;

(e) When used to determine steady speed fuel consumption, the instruments to record speed and measured distance may be driven by the test vehicle transmission if it can be shown that better representation of the road speed is obtained.

2. CALIBRATION OF THE CHASSIS DYNAMOMETER

2.1. Introduction

This paragraph sets out a procedure to be used to determine the power absorbed by the dynamometer.

The absorbed power comprises the power absorbed by frictional effects and by the power-absorption unit. The dynamometer is brought into operation at a speed greater than the maximum test speed. The device used for starting the dynamometer is then disconnected and the rotational speed of the driven roller decreases. The kinetic energy of the rollers is dissipated by the power-absorption unit and by the frictional effects. This method disregards variations in the roller's internal friction resulting from the presence or absence of load and friction in the rear roller if this is free.

This procedure identifies for every speed the relationship between the indicated power (P_i) and the absorbed power (P_a) of the dynamometer.

This relationship may be useful in practice to evaluate over a period of time the power absorbed by friction in the dynamometer and to reproduce the same total road load power on different days or on different bench units of the same type.

2.2. Calibration of the indicated power P_i (at 50 km/h) in relation to absorbed power (P_a)

The following procedure shall be used:

2.2.1. Measure the rotational speed of the roller if this has not already been done. A fifth wheel, a revolution counter or some other method may be used.

2.2.2. Place the vehicle on the dynamometer or apply some other method of starting the dynamometer.

2.2.3. Use the fly-wheel or other system of inertia simulation for the particular inertia class under consideration.

2.2.4. Bring the dynamometer to a speed of 50 km/h.

2.2.5. Note the indicated power (P_i).

2.2.6. Bring the dynamometer to a speed of 60 km/h.

2.2.7. Disconnect the device used to start the dynamometer.

2.2.8. Note the time taken by the dynamometer to coast down from a speed of 55 km/h to a speed of 45 km/h.

2.2.9. Set the power-absorption device at a different level.

2.2.10. Repeat the procedure set out in paragraphs 2.2.4. to 2.2.9. above sufficiently often to cover the range of road powers used.

2.2.11. Calculate the absorbed power, using the formula:

$$P_a = \frac{M_1 (V_1^{\,2} - V_2^{\,2})}{2\,000\ t}$$

where:

P_a = absorbed power in kW

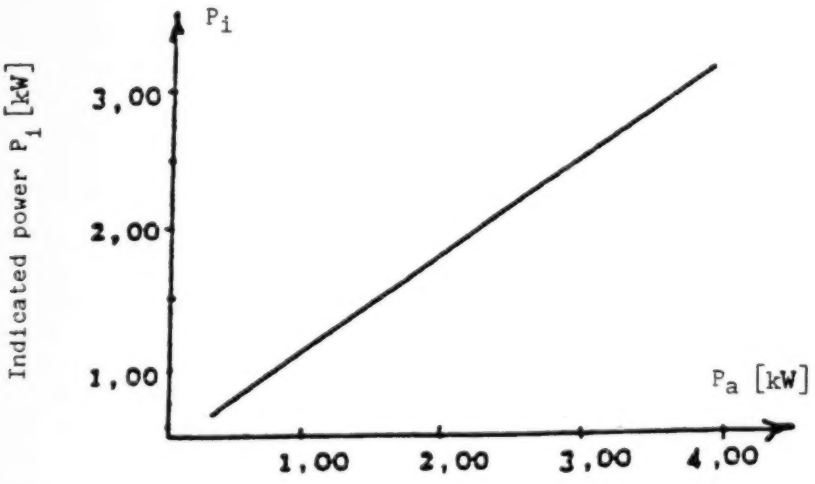
M_1 = equivalent inertia in kg (excluding the inertia of the free rear roller if the rollers are not coupled)

V_1 = initial speed in m/s (55 km/h = 15.28 m/s)

V_2 = final speed in m/s (45 km/h = 12.50 m/s)

t = time taken by the roller to coast down from 55 km/h to 45 km/h.

2.2.12. Identify the relationship between the indicated power (P_i) at 50 km/h and the absorbed power (P_a) at the same speed.



Absorbed power P_a at 50 km/h

2.2.13. The procedure set out in paragraphs 2.2.3. to 2.2.12. shall be repeated for all inertia classes to be considered.

2.3. Calibration of the indicated power (P_i) in relation to absorbed power (P_a) at other speeds

The procedure of paragraph 2.2. shall be repeated as often as necessary for other chosen speeds.

3. DETERMINATION OF THE TOTAL POWER OF A VEHICLE DRIVEN ON THE DYNAMOMETER

As indicated in paragraph 1.2.1. of this appendix, the total-power is equal to the rolling resistance plus the power absorbed by the bench dynamometer.

The determination of total power is effected either by the coast-down method or by measurement of the torque.

Annex 5 - Appendix 3

DETERMINATION OF THE TOTAL ROAD LOAD POWER OF A VEHICLE AND CALIBRATION OF THE DYNAMOMETER

1. INTRODUCTION

The purpose of this appendix is to define the method of measuring the total road load power of a vehicle at constant speed with a statistical accuracy of ± 2% and to reproduce this road load power on a dynamometer with an accuracy of ± 3%.

2. CHARACTERISTICS OF THE TRACK

The test track shall be level and sufficiently long to allow the measurements specified below to be performed; its gradient shall not exceed 1.5%.

3. ATMOSPHERIC CONDITIONS

3.1. Wind

Testing shall be performed at wind speeds averaging less than 3 m/s with peak speeds less than 5 m/s. In addition, the vector component of the wind speed across the test track must be less than 2 m/s. Wind velocity shall be measured at 0.7 m above the track surface.

3.2. Humidity

The track shall be dry.

3.3. Reference conditions

Pressure	H_o = 100 kPa
Temperature	T_o = 293 K (20° C)

3.3.1. Air density

3.3.1.1. The air density when the vehicle is tested, calculated as described in paragraph 3.3.1.2. below, shall not differ by more than 7.5% from the air density under the reference conditions.

3.3.1.2. The air density shall be calculated by the formula:

$$d_T = d_o \cdot \frac{H_T}{H_o} \cdot \frac{T_o}{T_T}$$

where:

d_T = air density at test conditions

d_o = air density at reference conditions

H_T = total test pressure

T_T = absolute temperature during the test (K).

3.3.2. Ambient conditions

3.3.2.1. The ambient temperature shall be between 5° C (278 K) and 35° C (308 K) and the barometric pressure between 91 kPa and 104 kPa. The relative humidity shall be less than 95%.

3.3.2.2. However, with the manufacturer's agreement, the tests may be made at lower ambient temperatures down to 1° C. In this case the correction factor calculated for 5° C should be used.

4. PREPARATION OF THE VEHICLE

4.1. Running-in

The vehicle shall be in normal running order and adjustment after having been run in for at least 3,000 km. The tyres shall be run in at the same time as the vehicle or shall have a tread depth within 10% and 50% of the initial tread depth.

4.2. Checks

The following checks shall be made in accordance with the manufacturer's specifications for the use considered: wheels, wheel trim, tyres (make, type, pressure), front axle geometry, brake adjustment (elimination of parasitic drag), lubrication of front and rear axles, adjustment of the suspension and vehicle attitude, etc.

4.3. Preparation for the test

4.3.1. The vehicle shall be loaded to its reference mass. The attitude of the vehicle shall be that obtained when the centre of gravity of the load is situated in the middle of the straight line joining the "R" points of the front outer seats.

The determination of the total road load power at constant speeds of 90 and 120 km/h to be simulated on the dynamometer for measurement of the fuel consumption must take due account of the vehicle mass as defined in paragraph 3.1.1. of annex 4 to this Regulation.

4.3.2. In the case of track tests, the windows of the vehicle shall be closed. Any covers for air conditioning systems, headlights, etc. shall be closed.

4.3.3. The vehicle shall be clean.

4.3.4. Immediately before the test, the vehicle shall be brought to normal running temperature in an appropriate manner.

5. METHODS

5.1. Energy variation during coast-down

5.1.1. Total road load power determination

5.1.1.1. Measurement equipment and accuracy

The margin of measurement error shall be less than 0.1 s for time and less than ± 0.5 km/h for speed.

5.1.1.2. Test procedure

5.1.1.2.1. Accelerate the vehicle to a speed of 5 km/h greater than the speed at which test measurement begins.

5.1.1.2.2. Put the gearbox to neutral.

5.1.1.2.3. Measure the time t_1 taken for the vehicle to decelerate from $V2 = V + \triangle V$ km/h to $V1 = V - \triangle V$ km/h
where: $\triangle V$ < 5 km/h for nominal speed < 50 km/h
$\triangle V$ < 10 km/h for nominal speed > 50 km/h.

5.1.1.2.4. Carry out the same test in the opposite direction: t_2

5.1.1.2.5. Take the average T_1 of the two times t_1 and t_2.

5.1.1.2.6. Repeat these tests until the statistical accuracy (p) of the average

$$T = \frac{1}{n} \sum_{i=1}^{n} T_i$$

is equal to or less than 2% (p < 2%).

The statistical accuracy (p) is defined by:

$$p = \frac{t\,s}{n} \cdot \frac{100}{T}$$

where:

t = coefficient given by the table below

s = standard deviation; $s = \sqrt{\sum_{i=1}^{n} \frac{(Ti - T)^2}{n - 1}}$

n = number of tests

n	4	5	6	7	8	9	10	11	12	13	14	15
t	3.2	2.8	2.6	2.5	2.4	2.3	2.3	2.2	2.2	2.2	2.2	2.2
$\frac{t}{\sqrt{n}}$	1.6	1.25	1.06	0.94	0.85	0.77	0.73	0.66	0.64	0.61	0.59	0.57

5.1.1.2.7. Calculate the power by the formula:

$$P = \frac{M \cdot V \cdot \Delta V}{500\ T}$$

where:

P is expressed in kW

V = test speed in m/s

ΔV = speed deviation from speed V in m/s

T = time in seconds

M = vehicle mass in kg.

5.1.1.2.8. The total road load power (P_T) determined on the track shall be corrected to the reference ambient conditions as follows:

P_T corrected = K P_T measured

$$K = \frac{R_R}{R_T}\left[1 + K_R\,(t - t_o)\right] + \frac{R_{AERO}}{R_T}\,\frac{(\rho_o)}{\rho}$$

where:

R_R = rolling resistance at speed V

R_{AERO} = aerodynamic drag at speed V

R_T = total road load = $R_R + R_{AERO}$

K_R = temperature correction factor of rolling resistance, taken to be equal to: $3.6 \cdot 10^{-3}/°\,C$

t = road test ambient temperature in ° C

t_o = reference ambient temperature = 20° C

ρ = air density at the test conditions

ρ° = air density at the reference conditions (20° C; 100 KPa)

The ratios R_R/R_T and R_{AERO}/R_T shall be specified by the vehicle manufacturer on the basis of the data normally available to the company.

If these values are not available, subject to the agreement of the manufacturer and the technical service concerned, the figures for the rolling/total resistance ratio given by the following formula may be used:

$$\frac{R_R}{R_T} = a\,M + b$$

where:

M = vehicle mass in kg

and for each speed the coefficients a and b are as shown in the following table

V (km/h)	a	b
20	$7.24 \cdot 10^{-5}$	0.82
30	$1.25 \cdot 10^{-4}$	0.67
40	$1.59 \cdot 10^{-4}$	0.54
50	$1.86 \cdot 10^{-4}$	0.42
90	$1.71 \cdot 10^{-4}$	0.21
120	$1.57 \cdot 10^{-4}$	0.14

5.1.2. Setting of the dynamometer

The purpose of this procedure is to simulate on the dynamometer the total road load power at a given speed.

5.1.2.1. Measurement equipment and accuracy

The measuring equipment shall be identical to that used on the track.

5.1.2.2. Test procedure

5.1.2.2.1. Install the vehicle on the dynamometer.

5.1.2.2.2. Adjust the tyre pressure (cold) of the driving wheels as required for the roller bench.

5.1.2.2.3. Adjust the equivalent inertia mass of the bench.

5.1.2.2.4. Bring the vehicle and bench to stabilized operating temperature.

5.1.2.2.5. Carry out the operations specified in paragraph 5.1.1.2. with the exception of paragraphs 5.1.1.2.4. and 5.1.1.2.5., replacing M by I in the formula given in paragraph 5.1.1.2.7.

5.1.2.2.6. Adjust the brake to reproduce the corrected total road load power (paragraph 5.1.1.2.8.) and to take into account the difference between the vehicle mass on the track and the equivalent inertia test mass (I) to be used. This may be done by calculating the mean corrected road coast-down time from V_2 to V_1 and reproducing the same time on the dynamometer by the following relationship:

$$T_{corrected} = T_{\frac{measured}{K}} \cdot \frac{I}{M}$$

5.1.2.2.7. The power P_a to be absorbed by the bench should be determined in order to enable the same total road load power to be reproduced for the same vehicle on different days or on different bench units of the same type.

5.2. Method of torque measurement at constant speed

5.2.1. Total torque determination on the track

5.2.1.1. Measurement equipment and accuracy

Torque measurement equipment shall have an accuracy of ± 2%. The margin of error in measuring speed shall not exceed ± 0.5% km/h.

5.2.1.2. Test procedure

5.2.1.2.1. Bring the vehicle to the chosen stabilized speed V.

5.2.1.2.2. Record the torque $C_{(t)}$ and speed over a period of at least 20 s. The accuracy of the data recording system shall be at least ± 1 Nm for the torque and ± 0.2 km/h for the speed.

5.2.1.2.3. Within the measuring period the variation coefficient (standard deviation divided by the average value) shall not exceed 2% for the speed or for the torque. The standard deviation shall be calculated from equidistant sampling points not more than one second apart. If this requirement cannot be met, the measuring period shall be sufficiently lengthened until the requirement is met.

5.2.1.2.4. The torque C_{ti} is the average torque derived from the following formula:

$$C_{ti} = \frac{1}{\Delta t} \int_{t}^{t+\Delta t} C(t)\, dt$$

5.2.1.2.5. The test shall be carried out three times in each direction. Determine the average torque from these six measurements for the reference speed. If the average speed deviates by more than 1 km/h from the reference speed, a linear regression shall be used for calculating the average torque.

5.2.1.2.6. If a total road load curve is necessary, it shall be calculated from the torque values obtained at at least seven equidistant speeds. The data points for a reference speed may be represented separately as speed/torque pairs.

5.2.1.2.7. The average torque C_T determined on the track shall be corrected to the reference ambient conditions as follows:

C_T corrected = K C_T measured,

where K is defined as in paragraph 5.1.1.2.8. of this appendix.

5.2.2. Type and setting of the dynamometer

5.2.2.1. Measurement equipment and accuracy

The equipment shall be identical with that used for the track.

5.2.2.2. Test procedure

5.2.2.2.1. Perform the operations specified in paragraphs 5.1.2.2.1. to 5.1.2.2.4. above.

5.2.2.2.2. Perform the operations specified in paragraphs 5.2.1.2.1. to 5.2.1.2.4. above for different settings of the power absorption unit.

5.2.2.2.3. Adjust the power absorption unit to reproduce the corrected total track torque of paragraph 5.2.1.2.7.

5.2.2.2.4. Proceed with the same operations as in paragraph 5.1.1.2.7., for the same purpose.

5.3. Gyroscopic platform method of measuring deceleration

5.3.1. Determination of the average power absorbed on the track

5.3.1.1. Measurement equipment and accuracy

The equipment for measuring deceleration shall be accurate to within ± 1%. The vehicle pitching angle shall be measured to an error within ± 1%, time within 0.1 s and speed within ± 0.5 km/h.

5.3.1.2. Test procedure

5.3.1.2.1. It may be necessary for the following setting to determine the pitching angle (α °) of the gyroscopic platform, after its installation in the vehicle, on a reference horizontal ground.

5.3.1.2.2. Immediately before testing, set the gyroscopic axis at the vertical with the vehicle on the horizontal reference ground.

5.3.1.2.3. Accelerate the vehicle to a speed of at least 5 km/h greater than the test speed V.

5.3.1.2.4. Put the gearbox to neutral.

5.3.1.2.5. Record the deceleration time t and axis deviation α during deceleration between V + 5 km/h and V - 5 km/h.

5.3.1.2.6. The time elapsing between the operation described in paragraph 5.3.1.2.2. and measurement shall be as short as possible in order to avoid the need to take into account platform drift due to the rotation of the earth.

5.3.1.2.7. Calculate the average deceleration $\bar{\gamma}_i$ corresponding to the speed V by the formula

$$\bar{\gamma}_1 = \frac{1}{t} \int_0^t \left[\gamma(t) - g \cos \alpha(t) \right] dt$$

where:

$\bar{\gamma}_1$ = average deceleration value at speed V in one direction of the test track

t = deceleration time between V + 5 km/h and V - 5 km/h

$\bar{\gamma}$ (t) = deceleration recorded during time t

g = 9.81 ms^{-2}

α (t) = gyroscopic axis deviation from the vertical

5.3.1.2.8. Perform the same test in the other direction of the test track to obtain $\bar{\gamma}_2$, repeating the operations described in paragraphs 5.3.1.2.1. to 5.3.1.2.6.

5.3.1.2.9. Calculate the average $\bar{\gamma}_i$ of $\bar{\gamma}_1$ and $\bar{\gamma}_2$:

$$\bar{\gamma}_i = \frac{\bar{\gamma}_1 + \bar{\gamma}_2}{2}$$

5.3.1.2.10. Perform a number of tests sufficient for the statistical accuracy p of the average

$$\bar{\gamma} = \frac{1}{n} \sum_i^n \bar{\gamma}_i$$

to be within 2% ($p < 2\%$).

The statistical accuracy p is defined by:

$$p = \frac{t \cdot s}{\sqrt{n}} \cdot \frac{100}{\bar{\gamma}}$$

where:

t = coefficient given by the table of paragraph 5.1.1.2.6. of this appendix

n = number of tests

s = standard deviation =

$$\sqrt{\frac{\sum_i^n (\bar{\gamma}_i - \bar{\gamma})^2}{n - i}}$$

5.3.1.2.11. Calculate the average power absorbed

$$\bar{F} = M \bar{\gamma}$$

where M is the actual mass of the vehicle on the track.

5.3.1.2.12. The average power absorbed $\bar{F}$ determined on the track shall be corrected to the reference ambient conditions as follows:

$$F_{corrected} = K \cdot F_{measured}$$

where K is defined as in paragraph 5.1.1.2.8. of this appendix.

5.3.2. Setting of the dynamometer

5.3.2.1. Measurement equipment and accuracy

The characteristics of the dynamometer used shall be as described in annex 5, appendix 2, paragraphs 1 and 2.

5.3.2.2. Test procedure

5.3.2.2.1. Determine the force Fa to be absorbed by the dynamometer at a given speed, with the characteristics of the dynamometer as defined in annex 5, appendix 2, to this Regulation.

At a constant speed on the dynamometer, the total force Ft is defined by the formula:

$$Ft = Fr + Fa$$

where Fr = rolling force exerted by the driving axle on the rollers

from which it follows that:

$$Fa = Ft - Fr$$

The total force Ft must be equal to the average corrected force as determined on the track (para. 5.3.1.2.12. above).

Therefore:

$$Fa = F_{corrected} - Fr$$

5.3.2.2.2. For the determination of F_a, the rolling force F_R to be subtracted from $\bar{F}_{corrected}$ must be known:

For single-roller dynamometers with a roller diameter greater than 1.5 m, the rolling force Fr at the chosen speed may be that specified for the track test by the manufacturer (para. 5.1.1.2.8.) multiplied by the ratio of the driving axle mass to the total mass. This value shall be checked by the technical service responsible for the tests;

For twin-roller dynamometers and for single-roller dynamometers with a roller diameter less than 1.50 m, the rolling force Fr is measured on the dynamometer at the chosen speed with the vehicle gearbox in neutral, by driving the rollers at the chosen speed and measuring the rolling force with precision apparatus accurate to within 2%.

5.3.2.2.3. It may be preferable, and is necessary if the value of F_R is uncertain, to observe the vehicle coast-down on the dynamometer:

Drive the vehicle to a speed of 10 km/h greater than the chosen speed;

Let the vehicle decelerate with the gearbox in neutral and continuously record the deceleration $\frac{d\omega}{dt}$

Calculate the total resistance F_t by the formula:

$$F_t = \frac{J}{R} \cdot \frac{d\omega}{dt}$$

where:

J = rotational inertia of the rollers' assembly plus the vehicle rotational mass (with gearbox in neutral)

R = radius of roller(s)

ω = angular speed

Vary the dynamometer load and repeat the previous determination until:

Ft = F corrected

Note the power (P_a) to be absorbed by the dynamometer for use in subsequent tests on the same vehicle type.

5.4. Alternative method

5.4.1. Subject to the agreement of the manufacturer and the test service, the total road load power of the vehicle under test may be assumed to be equal to a standard value derived from the following formula:

$$Pt = 1.1 (a_o M + b_o)$$

where:

Pt = total road load power (kW)

M = reference mass of the vehicle (kg)

a_o and b_o = coefficients depending on the speed as given in the table below:

V (km/h)	a_o	b_o
50	$2.13 \cdot 10^{-3}$	0.63
40	$1.60 \cdot 10^{-3}$	0.32
30	$1.14 \cdot 10^{-3}$	0.14
20	$0.73 \cdot 10^{-3}$	0.04

5.4.2. In the case of vehicles other than passenger cars, with a reference mass greater than 1,700 kg, the power values derived from the formula above shall be multiplied by the factor 1.3 instead of 1.1.

5.4.3. To set the dynamometer, either of the methods given in paragraph 5.1 (coast-down) or paragraph 5.2 (torque measurement) may be used.

5.5. Other methods of calibrating the roller bench guaranteeing the same accuracy may be used after agreement between the technical service responsible for the type approval tests and the manufacturer.

Annex 5 - Appendix 4

VERIFICATION OF INERTIAS OTHER THAN MECHANICAL

1. OBJECT

The method described in this appendix makes it possible to check that the simulated total inertia of the dynamometer is carried out satisfactorily in the running phases of the operating cycle.

2. PRINCIPLE

2.1. Drawing up working equations

Since the bench is subjected to variations in the rotating speed of the roller(s), the force at the surface of the roller(s) can be expressed by the formula:

$$F = I \cdot \gamma = I_M \cdot \gamma + F_I$$

where:

F = force at the surface of the roller(s)

I = total inertia of the bench (equivalent inertia of the vehicle: cf. table para. 2.2 of annex 4)

I_M = inertia of the mechanical masses of the bench

γ = tangential acceleration at roller surface

F_I = inertia force

The total inertia is expressed as follows:

$$I = I_M + \frac{F_I}{\gamma}$$

where:

I_M can be calculated or measured by traditional methods

F_I can be measured on the bench

γ can be calculated from the peripheral speed of the rollers.

The total inertia "I" will be determined during an acceleration or deceleration test with values higher than or equal to those obtained on an operating cycle.

2.2. Specification for the calculation of total inertia

The test and calculation methods must make it possible to determine the total inertia I with a relative error ($\triangle$ I/I) of less than 2%.

3. SPECIFICATIONS

3.1. The mass of the simulated total inertia I must remain the same as the theoretical value of the equivalent inertia (see para. 2.2 of annex 4) within the following limits:

3.1.1. ± 5% of the theoretical value for each instantaneous value,

3.1.2. ± 2% of the theoretical value for the average value calculated for each sequence of the cycle.

3.2. The limit given in paragraph 3.1.1. is brought to ± 50% for one second when starting and, for vehicles with manual transmission, for two seconds during gear changes.

4. VERIFICATION PROCEDURE

4.1. Verification is carried out during each test throughout the cycle defined in paragraph 2.1 of this annex.

4.2. However, if the provisions of paragraph 3 above are met, with instantaneous accelerations which are at least three times greater or smaller than the values obtained in the sequences of the theoretical cycle, the verification described above will not be necessary.

5. TECHNICAL NOTE

Explanation of drawing up working equations.

5.1. Equilibrium of the forces on the road

$$CR = k_1 J r_1 \frac{d\theta 1}{dt} + k_2 J r_2 \frac{d\theta 2}{dt} + k_3 M \gamma r_1 + k_3 F_s r_1$$

5.2. Equilibrium of the forces on dynamometer with mechanically simulated inertias

$$C_m = k_1 J r_1 \frac{d\theta 1}{dt} + k_3 J \frac{Rm \frac{dWm}{dt}}{Rm} r_1 + k_3 F_s r_1$$

$$= k_1 J r_1 \frac{d\theta 1}{dt} + k_3 I \gamma r_1 + k_3 F_s r_1$$

5.3. Equilibrium of the forces of dynamometer with non-mechanically simulated inertias

$$Ce = k_1 \, J \, r_1 \frac{d\omega 1}{dt} + k_3 \left(\frac{J \, Re \, \frac{d\omega e}{dt}}{Re} \, r_1 + \frac{C1}{Re} \, r_1 \right) + k_3 \, F_s \, r_1$$

$$= k_1 \, J \, r_1 \frac{d\omega 1}{dt} + k_3 \, (I_M \gamma + F_1) \, r_1 + k_3 \, F_s \, r_1$$

In these formulae:

CR = engine torque on the road

Cm = engine torque on the bench with mechanically simulated inertias

Ce = engine torque on the bench with electrically simulated inertias

$J \, r_1$ = Moment of inertia of the vehicle transmission brought back to the driving wheels

$J \, r_2$ = Moment of inertia of the non-driving wheels

J Rm = Moment of inertia of the bench with mechanically simulated inertias

J Re = Moment of mechanical inertia of the bench with electrically simulated inertias

M = Mass of the vehicle on the road

I = Equivalent inertia of the bench with mechanically simulated inertias

I_M = Mechanical inertia of the bench with electrically simulated inertias

Fs = Resultant force at stabilized speed

C1 = Resultant torque from electrically simulated inertias

F1 = Resultant force from electrically simulated inertias

$\frac{d\omega 1}{dt}$ = Angular acceleration of the driving wheels

$\frac{d\omega 2}{dt}$ = Angular acceleration of the non-driving wheels

$\frac{d\omega m}{dt}$ = Angular acceleration of the mechanical bench

$\frac{d\omega e}{dt}$ = Angular acceleration of the electrical bench

γ = Linear acceleration

r_1 = Radius under load of the driving wheels

r_2 = Radius under load of the non-driving wheels

Rm = Radius of the rollers of the mechanical bench

Re = Radius of the rollers of the electrical bench

k_1 = Coefficient dependent on the gear reduction ratio and the various inertias of transmission and "efficiency"

k_2 = Ratio transmission . $\frac{r1}{r2}$. "efficiency"

k_3 = Ratio transmission . "efficiency"

5.4. Assuming two types of bench (para. 5.2. and 5.3. above) have the same characteristics simplifying the following formula is obtained:

$$k_3 (I_M . \gamma + F_1) \; r_1 = k3I . \gamma \; .r1$$

hence,

$$I = I_M + \frac{F_1}{\gamma}$$

Annex 6

CHECKS OF CONFORMITY OF PRODUCTION

1. General

These requirements refer to tests to be made to check conformity of production in accordance with paragraph 8.4.3.

2. Test procedures

The test methods and the measuring instruments used shall be those described in annex 4 to this Regulation.

3. Collection of samples

A vehicle shall be selected by the inspector. If, following the test referred to in paragraph 5.1. below, this vehicle is not considered to conform to the requirements of this Regulation, another two vehicles shall be selected by the inspector to undergo the test.

4. Measurement criteria

During the tests for conformity of production, the value of fuel consumption measured shall not differ by more than 10% from the approved figure.

5. Assessment of results

5.1. If the value of the fuel consumption measured according to paragraph 2. above meets the requirements of paragraph 4. above, production is considered to conform to the approved type.

5.2. If the requirements of paragraph 4. above are not met, two other vehicles shall be tested in the same way.

5.3. If the value of the fuel consumption of the second and/or third vehicle of paragraph 5.2. does not meet the requirements of paragraph 4. above, production shall be considered not to conform to the requirements of this Regulation and the provisions of paragraph 8.4.5. shall be put into effect.